Aceh Journal of Animal Science (2019) 4(1): 42-49
DOI: 10.13170/ajas.4.1.13799
Printed ISSN 2502-9568 Electronic ISSN 2622-8734

RESEARCH PAPER

Distribution and length-weight relationships of Hilsa shad *Tenualosa ilisha* in the Bilah River, Labuhanbatu Regency, North Sumatera Province, Indonesia

Rusdi Machrizal*, Khairul Khairul, Juliana Nasution, Rivo Hasper Dimenta, Arman Harahap
Biology Education Study Program, Sekolah Tinggi Keguruan dan Ilmu Pendidikan Labuhanbatu, Rantauprapat, Indonesia. *Corresponding author, email: rusdimachrizal@gmail.com

Received: 25 May 2019
Accepted: 9 July 2019

ABSTRACT

Hilsa shad *Tenualosa ilisha* is one of the indigenous fish species and the icon of the Labuhanbatu Regency, Indonesia. Presently, very limited study was done in this species. Hence, the purpose of this study was to analyze the distribution and growth patterns based on the length-weight relationship of Hilsa shad *T. ilisha* on Bilah River, Labuhanbatu District, Sumatera Utara Province, Indonesia. Sampling was carried out for three months from February to April 2019 with the exploration method. Sampling locations was determined based on information from local fishermen. The Morisita index was used to analyse the distribution pattern, while growth patterns was analysed using the Linear Allometric Model (LAM). The results showed that Hilsa shad is distributing in groups or clustered with the Morisita index value of 2.211-2.314. The growth pattern of the fish was a negative allometric with a value of b<3. The correlation analysis showed that DO was firmly related to distribution (r^2=0.661). Meanwhile, light penetration was closely related to growth patterns (r^2=0.914). It is concluded that the distribution of Hilsa shad fish in the Bilah River was in groups or clustered with a negative allometric growth pattern.

Keywords: Hilsa Shad, distribution, growth pattern, *Tenualosa ilisha*

INTRODUCTION

Hilsa shad is a pelagic group of fish from the Clupeidae family commonly known as herring in Europe. In Asia, there were five species of Hilsa shad have been described, namely; *Tenualosa ilisha*, *T. macrura*, *T. toli*, *T. reevesii* and *T. thibaudeaui*. In Indonesia, Hilsa shad are only found on the east coast of Sumatera, including *T. macrura* in the Estuarine waters of Bengkalis, Riau Province; *T. ilisha* in Labuhanbatu, North Sumatera and *T. toli* in the Pemangkat area, Kalimantan (Suwarso, 2014; Hossain *et al.,* 2019). *Tenualosa ilisha* is one of the fish that has become the icon of Labuhanbatu. These fish are distributed in several regions of Asia and the Middle East waters (Hashemi *et al.,* 2010; Karim *et al.,* 2019). This species is an anadromous fish, hence it can be found in freshwater, brackish water, coastline and sea (Hossain *et al.,* 2014). This fish is the main target for fishing by local fishermen. According to Efizon *et al.* (2012) and Jihad *et al.* (2014), the Hilsa shad populations in Labuhanbatu waters have been sharply declined over the years, this was due to intensive fishing especially the broodfish to collect the eggs for commercial used.

Several studies on the Hilsa shad have been reported by several researchers, for example related to Livelihood status of Hilsa (*Tenualosa ilisha*) fishermen of greater Noakhali Regions of

Bangladesh (Sarker *et al*., 2016), gonadal development and growth pattern (Flura *et al*., 2015), age and spawning time of Hilsa shad in the bay of Bengal, India (Panhwar *et al*., 2011;), in coastal waters of the Northwest of Persian Gulf (Roomiani *et al*., 2014), and the river Tentulia in Bangladesh (Karim *et al*., 2015). Meanwhile, in Labuhanbtu, study on reproductive aspects of Hilsa shad has been reported by Jihad *et al.* (2014). In addition, the study on the length-weight relationships of Hilsa shad in Chilika Lake, Odisha waters has been reported by Mohanty and Nayak (2017), but no related study was reported on Hilsa shad in the Labuhanbatu waters, Indonesia. Therefore, the objective of the present study was to analyse the distribution, growth patterns and the length-weight relationship of the Hilsa shad harvested from Bilah River, Labuhanbatu District, Indonesia.

MATERIALS AND METHODS

Time and Site

The research was conducted in February-April 2019, at Bilah River, Labuhanbatu District, Sumatera Utara Province, Indonesia. The sampling location of Hilsa Shad fish was at the coordinates; 2° 28' 32,68" N and 100° 5' 4,88" E; 2° 29' 38,55" N and 100° 6' 41,93" E; 2° 30' 16,53" N and 100° 7' 46,51" E (fig.1). Data analysis was carried out at the basic biology laboratory of STKIP (Sekolah Tinggi Keguruan dan Ilmu Pendidikan) Labuhanbatu, Indonesia.

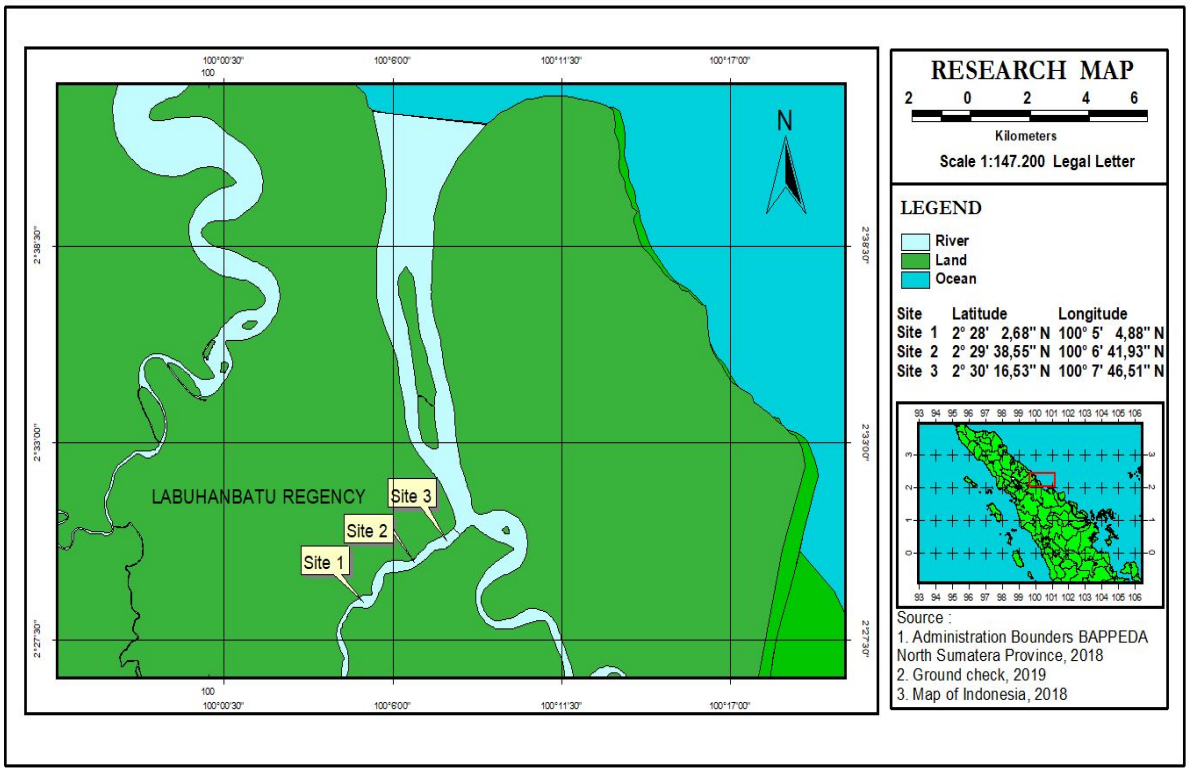

Figure 1. Map of Bilah River, Labuhanbatu District, Sumatera Utara Province, showing sampling site (marking).

Sampling Procedure

The sampling location was determined based on information from local fishermen about where these fish is usually found. Sampling was done four times in one month starting from 7.00 AM to 4.00 PM for three months. Fish was caught using gill net with three mesh sizes (2, 3 and 4) inches.

The caught fish samples measured for the weight (g) using a digital scales (ACIS Multi-Function digital Series AW-15X, error = 1g) and the total length (cm) using digital rulers (Insize Digital Protractor 2176-200, error= 0,5 cm).

Distribution

Identifying the distribution (pattern of distribution) of fish (in groups, randomly, or uniformly) were using the Morisita Spread Index (Khouw, 2009) based on the formula:

$$Id = n[\frac{\sum X^2 - \sum X}{(\sum X)^2 - \sum X}]$$

Description:

Id = Morisita Index

n = Number of plots / sample size

$\sum X$ = Number of individuals in each plot

$\sum X^2$ = The number of individuals in each plot is squared

With the distribution pattern criteria as follows:

- If *Id* value = 1, indicate the population distribution of random categories
- If *Id* value >1, indicate the population distribution of clustered/group categories
- If *Id* value <1, indicate the population distribution of uniform/even categories

Growth Pattern, and Relationship Between Water Quality and Distribution

The growth pattern was determined based on the relationship between total fish length and body weight using the Allometric Linear Model (ALM) based on Le Cren, (1951) as follow:

$$\boldsymbol{W = aL^b}$$

Where, W = Total body weight (g); L = Total length (mm); a = the intercept of the regression, *b* the regression coefficient. The relationship of water physical factors with the distribution and growth patterns of Hilsa Shad *Tenualosa ilisha* fish was calculated using Pearson correlation with the help of SPSS software (Statistical Product Service and Solution) version.22.

RESULTS

The study revealed that the fish length ranges between 24 cm to 40 cm and body weight ranges from 350 g to 720 g. The Morisita index of the fish at each station ranges from 2.211 to 2.314 (Table 1). Based on the analysis of distribution data from the results of the research, Hilsa shad fish at each station were categorized as clustered or grouped. The relationship between the length and body

weight of Hilsa shad fish was presented in the form of a simple linear regression equation. The results showed that there were differences in constant values b which ranges from 0.0339 to 1.773, indicate a negative allometric growth pattern (Table 2). The length and weight relationships of the fish from three different locations were presented the Figure 2.

Table 1. Morisita Value Index of Hilsa shad at each observation station

Station	Morisita	Category
1	2.314	clustered/grouped
2	2.211	clustered/grouped
3	2.211	clustered/grouped

Table 2. Relationship between length and weight of Hilsa shad at each station

Station	$W=aL^b$	Growth Pattern
1	$W=0.000486\ L^{1.773}$	Negative Allometric
2	$W=2.755403\ L^{0.0339}$	Negative Allometric
3	$W=0.000363\ L^{1.7335}$	Negative Allometric

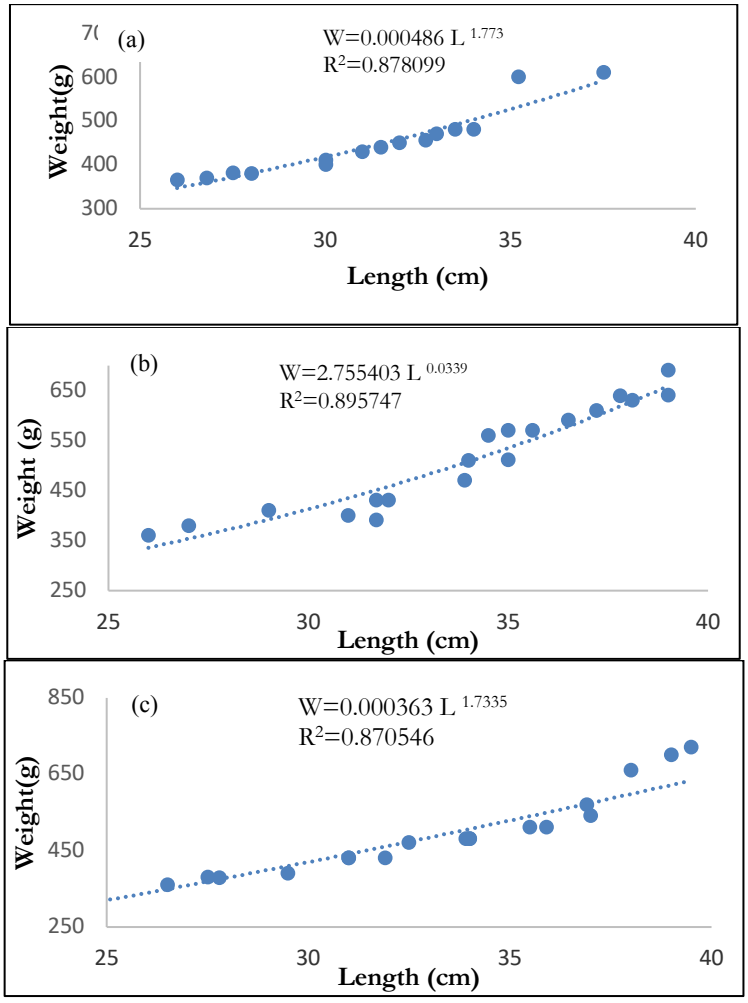

Figure 2. Length-weight relationships of the Hilsa shad fish *Tenualosa ilisha* in Bilah River, (a) station 1, (b) station 2, (c) station 3.

The measurement results of the average parameters of water quality during the research can be seen in Table 3. The results of the correlation analysis showed that water temperature, light penetration and water pH closely related to growth patterns. Whereas, the dissolved oxygen (DO) was closely related to distribution. This can be interpreted that Hilsa shad fish like waters with high oxygen levels. Further explanation can be seen in Table 4. The correlation analysis results showed that the physical and chemical factors of the waters had a positive correlation (+) with the distribution and growth patterns of Hilsa shad fish. It means that if the physical and chemical factors of the waters are in good condition resulted in higher of growth patterns and also well distributed

Table 3. Average data on observation of water quality at each station

Parameter	Unit	Quality standards	Station		
			1	2	3
Physics					
Water Temperature	^{O}C	28 - 32	27	28	31
Light Penetration	cm	> 3 m	12	11	11
Chemical					
Water pH	-	7 - 8.5	6.3	6.2	6.0
Salinity	‰	0	0	0	0
DO	mg/ liter	>5	6.3	6.8	6.4

Description: Station 1 (2^{o} 28' 32,68" N and 100^{o} 5' 4,88" E), Station 2 (2^{o} 29' 38,55" N and 100^{o} 6' 41,93" E), Station 3 (2^{o} 30' 16,53" N and 100^{o} 7' 46,51" E).

Table 4. Relationship of waters physical-chemical factors with distribution and growth patterns

Parameter	Distribution	Growth Pattern
Water Temperature	0.470	0.870
Light Penetration	0.255	0.914
Water pH	0.449	0.891
Salinity	-	-
DO	0.661	0.679

DISCUSSION

The Morisita index value at each observation station showed the id value >1, meaning that the distribution of hilsa shad fish showed a grouped or clustered pattern of distribution. This was thought to be caused by internal and external factors. The internal factors that influence the distribution are the hilsa shad fishway of life as grouped/clustered and anadromous migrating from the sea to the estuary and freshwater. The external factors that influence are physical, chemical, and the food of the fish. The same thing was also expressed by Suin (2002) that physical, chemical, and biological factors that are almost evenly distributed in water as well as food availability also influence living organisms in their habitat and determine which organisms live in groups, random, and uniform. According to Nazar *et al.* (2017) stated that the distribution pattern of this grouping type means that an individual type can only be found in a certain place according to the prefect of its habitat.

Based on the analysis results of the growth patterns at each station, it showed that the growth patterns of Hilsa shad were a negative allometric, meaning that the length increase was faster than the

body weight. Differences in fish growth expressed from the b value can be caused by several factors, such as differences in age, gonadal development, sex, habitat conditions, full stomach, disease and parasitic factors (Le Cren, 1951), food availability, pH, temperature, and dissolved oxygen in the water, and the ability of fish to swim actively or passively (Muchlisin *et al*., 2010). The negative allometric growth pattern has been reported in several species of fish in Indonesia, for example *Rasbora tawarensis* and *Poropuntius tawarensis* in Lake Laut Tawar (Muchlisin *et al*., 2010), mullet *Mugil cephalus* and seriding fish *Ambassis koopsii* (Mulfizar *et al*., 2012), keureling fish *Tor tambra* in the western region of Aceh Province, Indonesia (Muchlisin *et al*., 2015), halfbeak *Zenarchopterus dispar* in Northern Coast of Aceh (Fadhil *et al*., 2016), three species of groupers in Pulo Aceh waters, Aceh Besar District (Ramadhani *et al*., 2017), ponyfish *Aurigequula fasciata* and white-spotted spinefoot *Siganus canaliculatus* harvested from Ulelhee Bay, Banda Aceh City, Indonesia (Muchlisin *et al*., 2017), and grouper *Epinephelus coeruleopunctatus* in the coastal waters of Padang City (Bulanin *et al*., 2017). While, Panhwar *et al.* (2011) obtained an isometric growth pattern in female *T. ilisha* and positive allometric in male fish with a value of b 3.00-3.16 in Bangladeshi waters. The coefficient b value varies with a value of 2.6 - 3.02 in male fish and 2.80 - 3.03 in female fish found in Pakistan and Bangladesh. Allometric growth patterns are closely related to food availability, size increase, energy reserves, gonadal maturity and spawning time (Karim *et al.,* 2015; Dastagir *et al.,* 2014; Quddus *et al*., 1984; Batubara *et al*., 2019).

In the correlation of physical-chemical factors to the distribution of fish, the the dissolved oxygen (DO) most influences the fish distribution. The average DO value obtained in this research ranged from 6.3 to 6.8 mg/l. This value was higher when compared with the results of Jihad *et al.* (2014) who recorded the DO ranges from 1.3 to 3.7 mg /l. In the correlation of physical-chemical factors to the pattern of growth, the highest value was obtained in the parameter of light penetration (0.914). The average value of light penetration obtained in this research ranged from 11-12 cm. The numbers obtained indicated that the water conditions are quite turbid. Turbid water conditions are highly favoured by Hilsa shad. In agreement to Blaber *et al.* (1996) and Pang and Ong (2001) that Hilsa shad have a tendency to like turbid waters. It was stated that Hilsa shad fish have a large tolerance for turbidity, but the desired turbidity is which comes from organic matters containing food and also provides a camouflage.

CONCLUSIONS

The Morisita Index value (id) in all three study locations was >1 indicated that the distribution of Hilsa shad fish was in groups or clustered, and the growth pattern of Hilsa shad fish in the Bilah River was a negative allometric. The distribution was mostly influenced by dissolved oxygen, while the light penetration influence their growth pattern.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to Kemeristekdikti (Ministry of Research, Technology and Higher Education of the Republic of Indonesia) that has financed this research through the Program Hibah Kompetitif Nasional Skim Penelitian Dosen Pemula (The National Competitive Grand Program for Financing Novice Instructors' Research Schemes) in 2019.

REFERENCES

Batubara, A.S. Z.A. Muchlisin, D. Efizon, R. Elvyra, M. Irham. 2019. Length-weight relationships and condition factors of the naleh fish*, Barbonymus gonionotus* (Pisces, Cyprinidae) harvested from Nagan Raya Waters, Indonesia. Vestnik Zoologii, 53(1): 75–82.

Blaber, S.J.M., D.A. Milton, J. Pang, P. Wong, B.T. Ong, L. Nyigo, D. Lubim. 1996. The life history of the tropical shad Tenualosa toli from Sarawak: first evidence of protandry in the Clupeiformes. Journal Environmental Biology of Fishes, 46(3): 225-242.

Bulanin, B., M. Masrizal, Z.A. Muchlisin. 2017. Length-weight relationships and condition factors of the whitespotted grouper *Epinephelus coeruleopunctatus* Bloch, 1790 in the coastal waters of Padang City, Indonesia. Aceh Journal of Animal Science, 2(1): 23-27.

Dastagir, G., N.T. Narejo, Panezai, M.A. Jalbani. 2014. Length-weight study of fishes from Zhob River, Balochistan, Pakistan. Sindh University Research Journal (Science Series), 46(1): 15-18.

Efizon, D., S.D. Otong, Y. Dhahiyat, B. Koswara, B. 2012. Kelimpahan populasi dan tingkat eksploitasi ikan terubuk (*Tenualosa macrura*) di perairan bengkalis, Riau. Jurnal Berkala Perikanan Terubuk, 40(1): 52 – 65.

Fadhil, R., Z.A. Muchlisin, W. Sari. 2016. Hubungan panjang - berat dan morfometrik ikan julung- julung (*Zenarchopterus dispar*) dari perairan pantai utara Aceh. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah, 1(1): 146-159.

Flura., M. Zaher, B.M.S. Rahman, M.A. Rahman, P.A. Alam, M.M.H. Pramanik. 2015. Length-weight relationship and GSI of hilsa, *Tenualosa ilisha* (Hamilton, 1822) fishes in Meghna river, Bangladesh. International Journal of Natural and Social Sciences, 2(3): 82-88.

Hashemi, S., G. Mohammadi, G. Eskandary. 2010. Population dynamics and stock assessment of Hilsa shad, (*Tenalosa ilisha* Hamilton-Buchanan, 1822) in coastal waters of Iran (Northwest of Persian Gulf). Australian Journal of Basic and Applied Sciences, 4(12): 5780-5786.

Hossain, M.S., S. Sarker, S.R.. Chowdhury, S.M. Sharifuzzaman. 2014. Discovering spawning ground of Hilsa shad (*Tenualosa ilisha*) in the coastal waters of Bangladesh. Ecological Modelling Journal, 2014(282): 59-68.

Hossain, M.S., S.M. Sharifuzzaman, M.A. Rouf, R.S. Pomeroy, D.M. Hossain, S.R. Chowdhury, S. Aftabuddin. 2019. Tropical Hilsa shad (*Tenualosa ilisha*): Biology, fishery and management. Fish and Fisheries Journal, 2019(20): 44-65.

Jihad, S.S., D. Efizon, R.M. Putra. 2014. Reproductive biology of the *Tenualosa ilisha* in Labuhanbatu Regency, Sumatera Utara Province. Jurnal Online Mahasiswa, 1(2): 1-10.

Karim, E., Q. Liu, M. Sun, P.P. Barman, S.J. Hasan. 2019. Assessing recent gradual upsurge of marine captured Hilsa stock (*Tenualosa ilisha*) in Bangladesh. Aquaculture and Fisheries Journal, 4: 156-165.

Karim, R., P.R. Roy, Z.F. Ahmed. 2015. Age and growth of hilsa shad, *Tenualosa ilisha* (Hamilton, 1822) of the river Tentulia in Bangladesh. Journal of Fisheries, 3(1): 227-232.

Khouw, A.S. 2009. Metode dan analisis kuantitatif dalam bioekologi laut. Pusat Pembelajaran dan Pengembangan Pesisir Laut (P4L), Bogor.

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology, 20(2): 201-219.

Mohanty, N., L. Nayak. 2017. Studies on length-weight relationship and condition factor of Hilsa ilisha from Chilika Lake, Odisha. International Journal of Fisheries and Aquatic Studies, 5(3): 35-38.

Muchlisin, Z.A., M. Musman, M.N. Siti-Azizah. 2010. Length-weight relationships and condition factors of two threatened fishes, *Rasbora tawarensis* and *Poropuntius tawarensis*, endemic to Lake Laut Tawar, Aceh Province, Indonesia. Journal of Applied Ichthyology, 26(6): 949-953.

Muchlisin, Z.A. A.S. Batubara, M. N. Siti-Azizah, M. Adlim, A. Hendri, N. Fadli, A. A. Muhammadar, S. Sugianto. 2015. Feeding habit and length weight relationship of keureling fish, *Tor tambra* Valenciennes, 1842 (Cyprinidae) from the western region of Aceh Province, Indonesia. Biodiversitas, 16(1): 89-94.

Muchlisin, Z.A., V. Fransiska, A.A. Muhammadar, M. Fauzi, A.S. Batubara. 2017. Length-weight relationships and condition factors of the three dominant species of marine fishes caught by traditional beach trawl in Ulelhee Bay, Banda Aceh City, Indonesia. Croatian Journal of Fisheries, 75: 142-154.

Mulfizar., Z.A. Muchlisin, I. Dewiyanti. 2012. Hubungan panjang berat dan faktor kondisi tiga jenis ikan yang tertangkap di perairan Kuala Gigieng, Aceh Besar, Provinsi Aceh. Depik, 1(1):1-9

Nazar, M., Zuraidah., K. Samsul. 2017. Pola distribusi urchin (*Echinoidea*) pada ekosistem terumbu karang (*coral reefs*) di perairan Iboih Kecamatan Sukakarya, Kota Sabang sebagai penunjang pratikum ekologi hewan. Prosiding Seminar Nasional Biotik, Banda Aceh, Indonesia, available at https://jurnal.ar-raniry.ac.id/index.php/PBiotik/article/view/2126/1580.pdf (Accessed 5 July 2019).

Panhwar, S.K., G. Siddiqui, Z. Ayub. 2011. Reproductive pattern and some biological features of anadromous fish *Tenualosa ilisha* (Family: *Clupeidae*) from Pakistan. Indian Journal of Geo-marine Sciences, 40(5): 687-696.

Pang, J., B.T. Ong. 2001. The culture and re-seeding of terubuk (*Tenualosa toli*) in Sarawak-Malaysia. Paper Presented at The International Terubuk Conference, Sarawak, Malaysia.

Quddus, M.M., A. Shimizu, M.Y. Nose. 1984. Comparison of age and growth of two types of Hilsa ilisha in Bangladesh waters. Bulletin of the Japanese Society of Scientific Fisheries, 50(2): 177-181.

Ramadhani, A., Z.A. Muchlisin, M.A. Sarong, A.S. Batubara. 2017. Hubungan panjang berat dan faktor kondisi ikan kerapu Famili Serranidae yang tertangkap di Perairan Pulo Aceh Kabupaten Aceh Besar, Provinsi Aceh. Depik, 6(2): 112-121.

Roomiani, L., A.M. Sotudeh, M.R. Hakimi. 2014. Reproductive biology of Hilsa shad (*Tenualosa ilisha*) in coastal waters of the Northwest of Persian Gulf. Iranian Journal of Fisheries Sciences, 13(1): 201-215.

Sarker, J.M., A.M.M.B. Uddin, S.A.M. Patwary, M.H. Tanmay, F. Rahman, F. 2016. Livelihood status of Hilsa (*Tenualosa ilisha*) fishermen of greater Noakhali Regions of Bangladesh. Fisheries and Aquaculture Journal, 7(2): 168-173.

Suin, M. N. 2002. Metode ekologi. Universitas Andalas, Padang

Suwarso. 2014. Sumber daya ikan terubuk (*Clupeidae: Tenualosa sp.*) di perairan pantai Pemangkat, Kalimantan Barat. Prosiding Seminar Nasional Ikan ke 8, 3-4 Juni, Bogor, Indonesia, available at http://iktiologi-indonesia.org/wp-content/uploads/2018/01/29-Suwarso-terubuk.pdf (Accessed 5 July 2019).